Qualification testing of welders — Fusion welding —

Part 1:
Steels

Épreuve de qualification des soudeurs — Soudage par fusion —

Partie 1: Aciers


ICS 25.160.01
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 9606-1 was prepared by Technical Committee ISO/TC 44, Welding and allied processes, Subcommittee SC 11, Qualification requirements for welding and allied processes personnel.

This second edition cancels and replaces the first edition (ISO 9606-1:1994), which has been technically revised.

ISO 9606 consists of the following parts, under the general title Qualification testing of welders — Fusion welding:

— Part 1: Steels
— Part 2: Aluminium and aluminium alloys
— Part 3: Copper and copper alloys
— Part 4: Nickel and nickel alloys
— Part 5: Titanium and titanium alloys, zirconium and zirconium alloys

Annexes A, B and C of this part of ISO/CD 9606-1 are for information only.
Introduction

The ability of a welder to follow verbal or written instructions and verification of a person's skills are important factors in ensuring the quality of the welded product.

The testing of a welder's skill in accordance with this standard depends on welding techniques and conditions used in which uniform rules are complied with, and standard test pieces are used.

The principle of this standard is that a qualification test qualifies a welder not only for the conditions used in the test, but also for all other conditions which are considered easier to weld in accordance with this standard. It is presumed that the welder has received training and/or has industrial practice within the range of qualification.

The qualification test can be used to qualify a welding procedure and a welder provided that all the relevant requirements e.g. test piece dimensions and testing requirements are satisfied (see ISO 15614-1).

At the end of its period of validity, the existing and valid qualification testing of welders in accordance with the requirement of a national standard may be revalidated according to this International standard. The new range of qualification will be interpreted in accordance with the requirements of this International standard.
Qualification testing of welders — Fusion welding —

Part 1:
Steels

1 Scope

This International Standard defines the requirements for qualification testing of welders for fusion welding of steels.

It provides a set of technical rules for a systematic qualification test of the welder, and enables such qualifications to be uniformly accepted independently of the type of product, location and examiner/examining body.

When qualifying welders, the emphasis is placed on the welder's ability to manually manipulate the electrode/welding torch/welding blowpipe and thereby producing a weld of acceptable quality.

The welding processes referred to in this standard include those fusion welding processes which are designated as manual or partly mechanized welding. It does not cover fully mechanized and automated welding processes (see ISO 14732).

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references only the edition cited applies. For undated references the latest edition of the referred document (including any amendments) applies.


ISO 3834-1:2005 Quality requirements for fusion welding of metallic materials – Part 1: Criteria for the selection of the appropriate level of quality requirements

ISO 3834-2:2005 Quality requirements for fusion welding of metallic materials – Part 2: Comprehensive quality requirements


ISO 3834-4:2005 Quality requirements for fusion welding of metallic materials – Part 4: Elementary quality requirements

ISO 3834-5:2005 Quality requirements for fusion welding of metallic materials – Part 5: Documents with which it is necessary to conform to claim conformity to the quality requirements of ISO 3834-2, ISO 3834-3 or ISO 3834-4


ISO 4063, Welding and allied processes — Nomenclature of processes and reference numbers

ISO 5173, Destructive tests on welds in metallic materials — Bend tests

ISO 5817, Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections
3 Terms and definitions

For the purposes of this part of ISO 9606, the following terms and definitions apply.

3.1 welder
person who holds and manipulates the electrode holder, welding torch or blowpipe by hand

[ISO/TR 25901]

3.2 manufacturer
person or organization that is responsible for the welding production

[ISO15607]

3.3 examiner
qualified person who has been appointed to verify compliance with the applicable standard

NOTE In certain cases, an external independent examiner can be required.

[ISO/TR 25901]

3.4 examining body
organization that has been appointed to verify compliance with the applicable standard

NOTE In certain cases, an external independent examining body can be required.

[ISO/TR 25901]
3.5 material backing
backing using material for the purpose of supporting molten weld metal

3.6 gas backing
backing using gas primarily for the purpose of preventing oxidation

3.7 flux backing
backing using flux primarily for the purpose of preventing oxidation

NOTE In submerged arc welding flux backing may also reduce the risk of a weld pool collapse

3.8 consumable insert
filler material that is placed at the root of the joint before welding to be completely fused into the root

3.9 layer
stratum of weld metal consisting of one or more runs

[ISO/TR 25901]

3.10 root run
in multi layer welding, the run(s) of the first layer deposited in the root

[ISO/TR 25901]

3.11 filling run
in multi layer welding, the run(s) deposited after the root run(s) and before the capping run(s)

[ISO/TR 25901]

3.12 capping run
in multi layer welding, the run(s) visible on the weld face(s) after completion of welding

[ISO/TR 25901]

3.13 deposited thickness
thickness of the weld metal excluding any reinforcement

[ISO/TR 25901]

3.14 leftward welding
gas welding technique in which the filler rod is moved ahead of the blow pipe in relation to the welding direction

[ISO/TR 25901]

3.15 rightward welding
gas welding technique in which the filler rod is moved behind the blow pipe in relation to the welding direction
ISO/DIS 9606-1: (E)

3.16
branch joint
joint of one or more tubular parts to the main pipe or to a shell

3.17
fillet weld
triangular weld in a square preparation for making a T-joint, corner or lap joint

3.18
verification
confirmation, through the provision of objective evidence, that specified requirements have been fulfilled

4 Reference numbers, symbols and abbreviated terms

4.1 General

The following abbreviations and reference numbers shall be used when completing the welder's qualification test certificate (see Annex A).

4.2 Reference numbers of welding processes

This standard covers the following manual or partly mechanized welding processes (reference numbers of welding processes for symbolic representations are listed in ISO 4063):

See ISO TR 25901 and ISO 857-1 for the definition of manual and partly mechanized welding.

111 manual metal arc welding
114 self-shielded tubular - cored arc welding
121 submerged arc welding with solid wire electrode (partly mechanised)
125 submerged arc welding with tubular cored electrode (partly mechanised)
131 MIG welding with solid wire electrode
135 MAG welding with solid wire electrode
136 MAG welding with flux cored electrodes
138 MAG welding with metal cored electrode
141 TIG welding with solid filler material
142 autogenous TIG welding
143 TIG welding with tubular cored filler material
145 TIG welding using reducing gas and solid filler material (wire/rod)
15 plasma arc welding
311 oxy - acetylene welding

NOTE The principles of this standard may be applied to other fusion welding processes.
4.3 Symbols and abbreviated terms

4.3.1 For test pieces

- $a$: design throat thickness
- BW: butt weld
- $D$: outside pipe diameter
- FW: fillet weld
- $l_1$: length of test piece
- $l_2$: half width of test piece
- $l_f$: examination length
- P: plate
- $s$: weld metal thickness or fused metal thickness in butt welds
- $t$: material thickness of test piece (plate or wall thickness)
- $s_1$: weld metal thickness of test piece for welding process 1
- $s_2$: weld metal thickness of test piece for welding process 2
- T: pipe 1)
- $z$: leg length of fillet weld.

4.3.2 For consumables

- nm: no filler metal

(classification by tensile strength)
- 03: rutile basic covering
- 10: cellulosic covering
- 11: cellulosic covering
- 12: rutile covering
- 13: rutile covering
- 14: rutile + iron powder covering
- 15: basic covering
- 16: basic covering
- 18: basic + iron powder covering
- 19: limenite covering
- 20: iron oxide covering
- 24: rutile + iron powder covering
- 27: iron oxide + iron powder covering
- 28: basic + iron powder covering
- 45: basic covering
- 48: basic covering

(classification by yield strength)
- A: acid covering
- B: basic covering or electrode core - basic
- C: cellulosic covering
- R: rutile covering or electrode core - rutile, slow freezing slag
- RA: rutile - acid covering
- RB: rutile - basic covering
- RC: rutile - cellulosic covering
- RR: rutile - thick covering
- M: electrode core - metal powder
- P: electrode core – rutile, fast freezing slag
- S: solid wire/rod

1) The word "pipe" alone or in combination, is used to mean "pipe", "tube" or "hollow section".
V electrode core - rutile or basic / fluoride
W electrode core - basic / fluoride, slow freezing slag
Y electrode core - basic / fluoride, fast freezing slag
Z electrode core - other types

4.3.3 For other weld details

fb flux backing
bs welding from both sides
ci consumable insert
lw leftward welding
mb material backing
gb gas backing
ml multi layer
nb welding with no material backing
rw rightward welding
sl single layer
ss single - side welding

4.3.4 For bend tests

A minimum tensile elongation after fracture required by the material specification
d diameter of the former or the inner roller
t_s thickness of the bend test specimen

5 Essential variables and range of qualification

5.1 General

The qualification of welders is based on essential variables. For each essential variable a range of qualification is defined. All test pieces shall be welded using the essential variables independently, except for 5.7 and 5.8. If the welder has to weld outside the range of welder qualification a new qualification test is required. The essential variables are:

- welding process(es),
- product type (plate or pipe),
- type of weld (butt or fillet),
- filler material group,
- welding consumable,
- dimension (material thickness and outside pipe diameter),
- welding position,
- weld detail(s) (backing, gas backing, consumable insert, backing flux, single side welding, both side welding, single layer, multi layer, leftward welding, rightward welding).

Note: The parent material group(s) – subgroup(s) in accordance with ISO 15608 that are used in the test should be recorded on the welder’s qualification test certificate.
5.2 Welding processes

Welding processes are defined in ISO 857-1 and listed in 4.2.

Each test normally qualifies only one welding process. A change of welding process requires a new qualification test.

Exceptions are as follows:

- A change from solid wire electrode 135 to a metal cored electrode 138 or vice versa does not require requalification (see Table 5).
- A change from solid wire electrode 121 to a tubular cored electrode 125 or vice versa does not require requalification (see Table 5).
- Welding with 141, 143 or 145 qualifies for 141, 142, 143 and 145 but 142 only qualifies for 142.
- When qualifying the welder with short circuit transfer mode (131, 135 and 138) this shall qualify other transfer modes but not vice versa.

However, it is permitted for a welder to be qualified for two or more welding processes by welding a single test piece (multi process joint) or by two or more separate qualification tests. The ranges of qualification concerning the weld material thickness for each welding process used and for the multi process joint for butt welds are given in Tables 1 and 6.
### Table 1 — Thickness range of weld metal for single and multi process joints for butt welds

<table>
<thead>
<tr>
<th>Welding process used for test piece</th>
<th>Deposited thickness range qualified according to Table 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single process joint</td>
</tr>
<tr>
<td>1 welding process 1 (ss nb)</td>
<td>s = s₁</td>
</tr>
<tr>
<td>2 welding process 2 (ss mb)</td>
<td>s = s₂</td>
</tr>
<tr>
<td>2 welding process 2</td>
<td>for welding process 1: s = s₁</td>
</tr>
<tr>
<td>3 welding with backing (ss mb)</td>
<td>s₁</td>
</tr>
<tr>
<td>4 welding without backing (ss nb)</td>
<td>s₂</td>
</tr>
</tbody>
</table>

#### 5.3 Product type

The qualification test shall be carried out on plate, pipe or other suitable product form. The following criteria are applicable:

a) Test piece welds with outside pipe diameter \( D > 25 \text{ mm} \) cover welds in plates;

b) Test piece welds in plates cover welds in fixed pipe of outside pipe diameter \( D \geq 500 \text{ mm} \); in accordance with Tables 9 and 10.

c) Test piece welds in plates covers welds in rotating pipes of outside pipe diameter \( D \geq 75 \text{ mm} \) for welding positions PA, PB, PC, and PD; in accordance with Tables 9 and 10.
5.4 Type of weld

The qualification test shall be carried out as butt or fillet weld. The following criteria are applicable:

a) Butt welds cover butt welds in any type of joint except branch connections (see also 5.4 c)).

b) Butt welds do not qualify fillet welds or vice versa; It is however permissible to qualify a fillet weld in combination with a butt weld, e.g. single-bevel joint preparation with permanent material backing (a minimum test piece thickness of 10 mm shall be used). See Annex C.

For this combination test all testing requirements specified in this standard shall be fulfilled and associated ranges of qualification shall be given based on the test conditions.

c) Butt welds in pipes qualify branch joints with an angle $\geq 60^\circ$ and the same range of qualification as in Tables 1 to 12. For a branch weld the range of qualification is based on the outside diameter of the branch.

d) For applications where the type of weld cannot be qualified by means of either a butt or fillet or for branch connections less than $60^\circ$ then a specific test piece should be used to qualify the welder, when specified (e.g. by the product standard).

e) Butt welds may qualify fillet welds if a supplementary fillet weld test piece (see Figure 3) is welded with each process, filler material (FM) group and electrode covering/core, in accordance with Tables 3, 4 and 5. The test piece shall be at least 10 mm thick, or the thickness of the butt weld test piece if the thickness is less, and completed using a single layer in the PB position. For this supplementary test the welder shall be qualified for all fillet welds as given for the butt weld qualification variables related to the range of qualification for fillet welds (e.g. tables 8, 10 and 12).

5.5 Filler material

5.5.1 Filler material groups

The qualification test shall be carried out with filler material from one of the groups according to Table 3. Welding with filler materials outside the filler material grouping in Table 2, a separate test is required.

The parent material used in a qualification test should be from any suitable material from material groups 1 through to 11 as identified in ISO/TR 15608.

5.5.2 Range of qualification

Filler material groups are defined in table 2:
Table 2 – Filler material grouping

<table>
<thead>
<tr>
<th>Group</th>
<th>Welding consumable for welding of</th>
<th>Examples of applicable standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM1</td>
<td>Non-alloy and fine grain steels</td>
<td>ISO 2560, ISO 14341, ISO 636, ISO 14171, ISO 17632</td>
</tr>
<tr>
<td>FM2</td>
<td>High strength steels</td>
<td>ISO 18275, ISO 16834, ISO 26304, ISO 18276</td>
</tr>
<tr>
<td>FM3</td>
<td>Creep-resisting steels Cr &lt; 3,75 %</td>
<td>ISO 3580, ISO 21952, ISO 24598, ISO 17634</td>
</tr>
<tr>
<td>FM4</td>
<td>Creep-resisting steels 3,75 ≤ Cr ≤ 12 %</td>
<td>ISO 3580, ISO 21952, ISO 24598, ISO 17634</td>
</tr>
<tr>
<td>FM5</td>
<td>Stainless and heat-resistant</td>
<td>ISO 3581, ISO 14343, ISO 17633</td>
</tr>
<tr>
<td>FM6</td>
<td>Nickel and nickel alloys</td>
<td>ISO 14172, ISO 18274</td>
</tr>
</tbody>
</table>

Welding with a filler material in one group qualifies the welder for welding with all other filler materials within the same group, as well as other groups according to Table 3, and welding on parent materials from groups 1 through 11.

Table 3—Range of qualification for filler material

<table>
<thead>
<tr>
<th>Filler used on test</th>
<th>FM1</th>
<th>FM2</th>
<th>FM3</th>
<th>FM4</th>
<th>FM5</th>
<th>FM6</th>
</tr>
</thead>
<tbody>
<tr>
<td>FM1</td>
<td>X</td>
<td>X</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>FM2</td>
<td>X</td>
<td>X</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>FM3</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>FM4</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>FM5</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>X</td>
<td>-</td>
</tr>
<tr>
<td>FM6</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Welding consumable for welding of:
- FM1 Non-alloy and fine grain steels: ISO 2560, ISO 14341, ISO 636, ISO 14171, ISO 17632
- FM2 High strength steels: ISO 18275, ISO 16834, ISO 26304, ISO 18276
- FM3 Creep-resisting steels Cr < 3,75 %: ISO 3580, ISO 21952, ISO 24598, ISO 17634
- FM4 Creep-resisting steels 3,75 ≤ Cr ≤ 12 %: ISO 3580, ISO 21952, ISO 24598, ISO 17634
- FM5 Stainless and heat-resisting: ISO 3581, ISO 14343, ISO 17633
- FM6 Nickel and nickel alloys: ISO 14172, ISO 18274

Key:
- X indicates those filler materials for which the welder is qualified.
- - indicates those filler materials for which the welder is not qualified.
5.6 Welding consumable

Welding with filler material qualifies for welding without filler material, but not vice versa.

Note: For process 142 and 311 (without filler material) the parent material group used in the test is the material group that the welder is qualified for.

The ranges of qualification for welding consumables are given in Tables 4 and 5.

Table 4 — Range of qualification for covered electrodes

<table>
<thead>
<tr>
<th>Welding process</th>
<th>Type of covering used in the test</th>
<th>Range of qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, RA, RB, RC, RR, R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>03, 13, 14, 19, 20, 24, 27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15, 16, 18, 28, 45, 48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>–</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10, 11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>–</td>
<td>–</td>
<td>X</td>
</tr>
</tbody>
</table>

a Abbreviations see 4.3.2.

b The type of covering used in the qualification test of welders for root run welding without backing (ss nb) is the type of covering qualified for root run welding in production with no backing (ss nb).

Key:

X indicates those welding consumables for which the welder is qualified.

– indicates those welding consumables for which the welder is not qualified.
Table 5 — Range of qualification for welding consumables\textsuperscript{a,b}

<table>
<thead>
<tr>
<th>Welding Process</th>
<th>Consumables used in test piece</th>
<th>Range of qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Solid wire (S)</td>
</tr>
<tr>
<td>131, 135, 145</td>
<td>Solid wire electrode (S)</td>
<td>X</td>
</tr>
<tr>
<td>121, 125, 138, 141, 143, 143, 15</td>
<td>Solid wire electrode (S)</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Metal cored electrode (M)</td>
<td>X</td>
</tr>
<tr>
<td>114, 136, 143</td>
<td>Flux cored electrode (B)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Flux cored electrode (R, P, V, W, Y, Z)</td>
<td>-</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Abbreviations see 4.3.2.

\textsuperscript{b} The type of flux cored wire used in the qualification test of welders for root run welding without backing (ss, nb) is the type of flux cored wire qualified for root run welding in production with no backing (ss, nb).

**Key:**

- indicates those welding consumables for which the welder is qualified.
- indicates those welding consumables for which the welder is not qualified.

### 5.7 Dimensions

The welder qualification test of butt welds is based on the deposited thickness and outside pipe diameters. The ranges of qualification are specified in Tables 6 and 7.

**NOTE** It is not intended that deposited thickness or outside pipe diameters should be measured precisely but rather the general philosophy behind the values given in Tables 6 and 7 should be applied.

For fillet welds the range of qualification for material thicknesses is specified in Table 8.

For test pieces of different outside pipe diameters and deposited thicknesses, the welder is qualified for:

- thinnest through to the thickest weld metal and/or parent metal thickness qualified, and
- the smallest through to the largest diameter qualified (refer to Tables 6 and 7).
Table 6 — Range of qualification of deposited thickness for butt welds

<table>
<thead>
<tr>
<th>Deposited thickness of test piece ( s )</th>
<th>Range of qualification ( ^a )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( s &lt; 3 )</td>
<td>( s ) to ( 3 a ) or ( s ) to ( 2s a ) whichever is greater</td>
</tr>
<tr>
<td>( 3 \leq s &lt; 12 )</td>
<td>( 3 ) to ( 2s b )</td>
</tr>
<tr>
<td>( s \geq 12c, d )</td>
<td>( \geq 3d )</td>
</tr>
</tbody>
</table>

\( a \) For oxy-acetylene welding (311): \( s \) to 1,5 \( s \)

\( b \) For oxy-acetylene welding (311): 3 to 1,5 \( s \)

\( c \) The test piece has to be welded in at least 3 layers

\( d \) For multi processes, \( s \) is deposited thickness for each process.

\( e \) For single process and same type of filler material \( s \) is equal to parent material \( t \)

\( f \) The range of qualification for deposited thicknesses of the branch joints is:
- For set on branch, see e.g. Figure 1a, the deposited thickness of the branch
- For set through and set in branches, see e.g. Figure 1b and Figure 1c, the deposited thickness of the main pipe or shell.

Table 7 — Range of qualification for outside pipe diameter \( ^a \)

<table>
<thead>
<tr>
<th>Outside pipe diameter of test piece ( D )</th>
<th>Range of qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>( D \leq 25 )</td>
<td>( D ) to ( 2 \times D )</td>
</tr>
<tr>
<td>( D &gt; 25 )</td>
<td>( \geq 0,5 \times D ) (25 mm min.)</td>
</tr>
</tbody>
</table>

\( a \) For non circular hollow sections, \( D \) is the dimension of the smaller side.

Table 8 — Range of qualification of material thickness for fillet welds

<table>
<thead>
<tr>
<th>Material thickness of test piece ( t )</th>
<th>Range of qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t &lt; 3 )</td>
<td>( t ) to ( 2t ), or ( 3 ) whichever is greater</td>
</tr>
<tr>
<td>( t \geq 3 )</td>
<td>( \geq 3 )</td>
</tr>
</tbody>
</table>

In the case of branch welding the deposited thickness criteria to which Table 6 applies and the outside pipe diameter criteria to which Table 7 applies is as follows:

— Set on: The deposited thickness and outside pipe diameter of the branch; Figure 1a
— Set in or set through: The deposited thickness of the main pipe or shell and the outside pipe diameter of the branch; Figure 1b and Figure 1c.

Figure 1a - Set-on branch

Figure 1b - Set-through branch

Figure 1c - Set-in branch

5.8 Welding positions

The range of qualification for each welding position is given in Tables 9 and 10. The welding positions and symbols refer to ISO 6947.

The test pieces shall be welded in accordance with the testing positions according to ISO 6947.
Welding two pipes with the same outside pipe diameter, one in welding position PH and one in welding position PC, also covers the range of qualification of a pipe welded in welding position H-L045 using upward welding.

Welding two pipes with the same outside pipe diameter, one in welding position PJ and one in welding position PC, also covers the range of qualification of a pipe welded in welding position J-L045 using downward welding.

Outside pipe diameters $D \geq 150$ mm can be welded in two welding positions (PH or PJ 2/3 of circumference, PC 1/3 of circumference) using only one test piece. This test covers all positions for the direction of welding that was used in the test.

Table 9 — Range of qualification for welding positions for butt welds

<table>
<thead>
<tr>
<th>Testing position</th>
<th>PA Flat</th>
<th>PC Horizontal</th>
<th>PE Overhead</th>
<th>PF Vertical up</th>
<th>PG Vertical down</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA</td>
<td>X</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>PC</td>
<td>X</td>
<td>X</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>PE (plate)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>PF (plate)</td>
<td>X</td>
<td>–</td>
<td>–</td>
<td>X</td>
<td>–</td>
</tr>
<tr>
<td>PH (pipe)</td>
<td>X</td>
<td>–</td>
<td>X</td>
<td>X</td>
<td>–</td>
</tr>
<tr>
<td>PG (plate)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>X</td>
</tr>
<tr>
<td>PJ (pipe)</td>
<td>X</td>
<td>–</td>
<td>X</td>
<td>–</td>
<td>X</td>
</tr>
<tr>
<td>PK</td>
<td>X</td>
<td>–</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>H-L045</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>–</td>
</tr>
<tr>
<td>J-L045</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>–</td>
<td>X</td>
</tr>
</tbody>
</table>

Key:
- indicates those welding positions for which the welder is qualified
- indicates those welding positions for which the welder is not qualified

Note: See also 5.3
### Table 10 — Range of qualification for welding positions for fillet welds

<table>
<thead>
<tr>
<th>Testing position</th>
<th>Range of qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PA Flat</td>
</tr>
<tr>
<td>PA</td>
<td>X</td>
</tr>
<tr>
<td>PB</td>
<td>X</td>
</tr>
<tr>
<td>PC</td>
<td>X</td>
</tr>
<tr>
<td>PD</td>
<td>X</td>
</tr>
<tr>
<td>PE (plate)</td>
<td>X</td>
</tr>
<tr>
<td>PF (plate)</td>
<td>X</td>
</tr>
<tr>
<td>PH (pipe)</td>
<td>X</td>
</tr>
<tr>
<td>PG (plate)</td>
<td>–</td>
</tr>
<tr>
<td>PJ (pipe)</td>
<td>X</td>
</tr>
</tbody>
</table>

Key:
- X indicates those welding positions for which the welder is qualified
- – indicates those welding positions for which the welder is not qualified

Note: See also 5.3

### 5.9 Weld details

Depending on the weld details, the ranges of qualification are shown in Tables 11 and 12.

When welding with process 311 a change from rightward welding to leftward welding and vice versa requires a new qualification test.

### Table 11 — Range of qualification for backings and consumable inserts

<table>
<thead>
<tr>
<th>Test condition</th>
<th>Range for qualification for backing and consumable inserts</th>
</tr>
</thead>
<tbody>
<tr>
<td>No backing (ss,nb)</td>
<td>X X X X – X</td>
</tr>
<tr>
<td>Material backing (ss,mb)</td>
<td>– X X – – –</td>
</tr>
<tr>
<td>Welding from both sides (bs)</td>
<td>– X X – – –</td>
</tr>
<tr>
<td>Gas backing (ss,gb)</td>
<td>– X X X – –</td>
</tr>
<tr>
<td>Consumable insert (ci)</td>
<td>– X X – X –</td>
</tr>
<tr>
<td>Flux backing (ss,fb)</td>
<td>– X X – – X</td>
</tr>
</tbody>
</table>

Key:
- X indicates those conditions for which the welder is qualified
- – indicates those conditions for which the welder is not qualified
### Table 12— Range of qualification of layer technique for fillet welds

<table>
<thead>
<tr>
<th>Test piece</th>
<th>Range of qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>single layer (sl)</td>
</tr>
<tr>
<td>single layer (sl)</td>
<td>X</td>
</tr>
<tr>
<td>multi layer (ml)</td>
<td>X</td>
</tr>
</tbody>
</table>

* During the welding of the test piece the examiner shall perform visual examination of the first layer in accordance with clause 7 of this standard

Key:
- X indicates the layer technique for which the welder is qualified
- – indicates the layer technique for which the welder is not qualified

### 6 Examination and testing

#### 6.1 Examination

The welding of test pieces shall be witnessed by the examiner or examining body. The testing shall be verified by the examiner or examining body.

The test pieces shall be marked with the identification of the examiner and the welder. Additionally welding positions for all test pieces shall be marked on the test piece and for fixed pipe welds, the 12 o’clock welding position shall also be marked.

The examiner or examining body may stop the test if the welding conditions are not correct or if it appears that the welder does not have the skill to fulfil the requirements, e.g. where there are excessive and/or systematic repairs.

#### 6.2 Test pieces

The shape and dimension of test pieces required are shown in Figures 2 to 5.

A minimum test piece length for plates of 200 mm is required; the examination length is 150 mm. For pipe circumferences less than 150 mm additional test pieces will be required with a maximum of three test pieces.
Figure 2 — Dimensions of test piece for a butt weld in plate

Key

$t$ material thickness of test piece

Dimensions in millimetres
Dimensions in millimetres

Key

\( t \)  material thickness of test piece
Note: the parent material may be of dissimilar thickness

**Figure 3 — Dimensions of test piece for a fillet weld on plate**

Dimensions in millimetres

Key

\( D \)  outside pipe diameter
\( t \)  material thickness of test piece (wall thickness)

**Figure 4 — Dimensions of test piece for a butt weld in pipe**
**Key**

- $D$: outside pipe diameter
- $l_1$: length of test piece
- $t$: material thickness of test piece (plate or wall thickness)

Note: the parent material may be of dissimilar thickness for the pipe and plate

**Figure 5 — Dimensions of test piece for a fillet weld on pipe**

### 6.3 Welding conditions

The qualification test of welders shall follow a pWPS or WPS prepared in accordance with ISO 15609-1 or ISO 15609-2. The required throat thickness of the fillet weld test piece shall be defined in the pWPS or WPS used for the test.

The following welding conditions shall apply:

- the test pieces shall have at least one stop and restart in the root run and be identified in the examination length to be examined. If two or more processes are used in a single test piece, the test piece shall also have at least one stop and restart in the capping run;

- the welder shall be allowed to remove minor imperfections by grinding, except for capping run for which only the stop and restart may be ground. The permission of the examiner or examining body shall be obtained;

- any postweld heat treatment required in the pWPS or WPS may be omitted at the discretion of the manufacturer.
6.4 Test methods

After welding the test piece shall be tested in accordance with Table 13.

If the weld is accepted by visual testing, the remaining test(s) according to Table 13 shall be carried out.

When material backing is used in the qualification test it shall be removed prior to destructive testing, and need not be removed before non-destructive testing (NDT).

The test specimen for macroscopic examination shall be prepared and etched on one side to clearly reveal the weld. Polishing is not required.

<table>
<thead>
<tr>
<th>Test method</th>
<th>Butt weld (in plate or pipe)</th>
<th>Fillet weld and branch connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual testing according to ISO 17637</td>
<td>mandatory</td>
<td>mandatory</td>
</tr>
<tr>
<td>Radiographic testing according to ISO 17636</td>
<td>mandatory a, b, d</td>
<td>not mandatory</td>
</tr>
<tr>
<td>Bend test according to ISO 5173</td>
<td>mandatory a, b, f</td>
<td>not applicable</td>
</tr>
<tr>
<td>Fracture test according to ISO 9017</td>
<td>mandatory a, b, f</td>
<td>mandatory c, e</td>
</tr>
</tbody>
</table>

a Either radiographic testing or bend or fracture tests shall be used.

b When radiographic testing is used, then additional bend or fracture tests are mandatory for welding processes 131, 135, 138 and 311.

c The fracture tests may be replaced by a macroscopic examination according to ISO 17639 of at least two sections at least one of which shall be taken from the stop/start location.

d The radiographic testing may be replaced by an ultrasonic testing according to ISO 17640 for thickness ≥ 8 mm on ferritic steels only.

e The fracture tests on pipes may be replaced by radiographic testing.

f For outside pipe diameter \( D \leq 25 \) mm, the bend or fracture tests may be replaced by a notched tensile test of the complete test piece (example is given in figure 9).

6.5 Test piece and test specimen

6.5.1 General

In 6.5.2 to 6.5.4 details of the type, dimensions and preparation of the test pieces and test specimens are given. In addition, the requirements for destructive tests are indicated. For root, face or side bend or fracture tests, one specimen shall be taken from the start and stop area in the examination length. For pipe butt welds in the PH, PJ, H-L045 and J-L045 positions test specimens shall be taken from the PE and PF/PG position, see Figure 8.

6.5.2 Butt weld in plate and pipe

When radiographic testing is used, the examination length of the weld (see Figures 6 and 8) in the test piece shall be radiographed.
6.5.2.1 Fracture testing only

When fracture testing is used, the test piece examination length except using the notch tensile test according to Figure 9 shall be cut into 4 test specimens of equal width in accordance with Table 14 and all of them tested in such a manner that the fracture will be reached. All notch preparations according to ISO 9017 are permitted.

NOTE In addition, the test specimen may be longitudinally notched in the centre of the weld of the tension side in order to achieve a fracture in the weld of the test specimen.

### Table 14 – Width of fracture test specimens

<table>
<thead>
<tr>
<th>Product type</th>
<th>Width of fracture test specimens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plates (P)</td>
<td>Outside diameter (D) of Pipes (T) a</td>
</tr>
<tr>
<td>X</td>
<td>≥ 100</td>
</tr>
<tr>
<td>_</td>
<td>50 ≤ D &lt; 100</td>
</tr>
<tr>
<td>_</td>
<td>25 &lt; D &lt; 50</td>
</tr>
</tbody>
</table>

a For pipes with outside diameter D ≤ 25 mm the notch tensile test piece according to Figure 9 is recommended.

6.5.2.2 Bend testing only

Bend tests shall be performed in accordance with ISO 5173.

When only bend testing is carried out the following conditions shall apply:

For thicknesses \( t \leq 12 \text{ mm} \), a minimum of 2 root and 2 face bend test specimens shall be used, and the complete examination length shall be tested.

For thicknesses \( t > 12 \text{ mm} \), 4 side bend test specimens shall be used approximately equally spaced along the examination length.

For pipe butt welds the 4 specimens shall be equally spaced as in accordance with the Figure 8.

In all cases at least 1 specimen shall be taken from a stop/start location.

When transverse bend testing or side bend testing is used, the diameter of the former or the inner roller shall be \( 4t \) and the bending angle 180° for parent metal with elongation \( A \geq 20 \% \). For parent metal with elongation \( A < 20 \% \), the following equation shall apply:

\[
d = \frac{100 \times t_s}{A} - t_s
\]

where
6.5.2.3 Additional bend or fracture test

When additional bend or fracture tests are required (see Table 12 footnote b) in all cases at least 1 specimen shall be taken from a stop/start location.

— For all plate butt welds one root and one face test specimen shall be tested or 2 side bend test specimens if applicable;

— For butt welds in pipe in PA or PC positions, one root and one face test specimen shall be tested or 2 side bend test specimens if applicable;

— For butt welds in pipe welded in all other welding positions, one root test specimen shall be taken from the PE (overhead) welding position and one face test specimen shall be taken from the PF (vertical up) position or the PG (vertical down) position or 2 side bend test specimens if applicable.

Dimensions in millimetres

Key

\( l_1 \) length of test piece
\( l_2 \) half width of test piece
\( l_f \) examination length

Sectioning into an even-numbered quantity of test specimens

Figure 6 — Preparation and fracture testing of test specimens for a butt weld in plate

6.5.3 Fillet weld on plate

For fracture tests (see figure 7) the test piece can be cut, if necessary, into several test specimens. Each test specimen shall be positioned for breaking in accordance with ISO 9017 and examined after fracture.

When macroscopic examination is used, at least two test specimens shall be taken. One macroscopic specimen shall be taken at the stop/start location.
Figure 7 — Examination length for fracture testing for a fillet weld on plate

Key

\( l_t \)  examination length

1 one root fracture or one root transverse bend or one side bend test specimen
2 one face fracture or one face transverse bend or one side bend test specimen
3 one root fracture or one root transverse bend or one side bend test specimen
4 one face fracture or one face transverse bend or one side bend test specimen

Sectioning of fracture or bend test specimens for welding positions

Figure 8 — Preparation and locations of test specimens for a butt weld in pipe
For \( t \geq 1.8 \text{ mm} \): \( d = 4.5 \text{ mm} \)
For \( t < 1.8 \text{ mm} \): \( d = 3.5 \text{ mm} \)

Holes are not allowed in start and stop areas.

NOTE Notch profiles s and q are also permitted in circumferential direction according to ISO 9017.

**Figure 9 — Example for notch tensile test for pipe test piece outside diameter \( \leq 25 \text{ mm} \)**

### 6.5.4 Fillet weld on pipe

For fracture tests, the test piece shall be cut into four or more test specimens and fractured.

When macroscopic examination is used, at least two test specimens shall be taken. One macroscopic specimen shall be taken at the stop/start location.

### 6.6 Test record

The results of all testing shall be documented in accordance with the relevant testing standard.

### 7 Acceptance requirements for test pieces

Test pieces shall be evaluated according to the acceptance requirements specified for relevant types of imperfections.

Prior to any testing the following shall be checked:

- all slag and spatters are removed;
- no grinding on the root and the face side of the weld (according to 6.3);
- stop and restart in the root run and in the capping run are identified (according to 6.3);
- profile and dimensions.

The acceptance requirements for imperfections found by test methods according to this standard shall, unless otherwise specified, be assessed in accordance with ISO 5817. A welder is qualified if the imperfections are within quality level B in ISO 5817, except for imperfections types as follows; excess weld metal (502), excessive convexity (503), excessive throat thickness (5214), excessive penetration (504), incorrect weld toe (505) and undercut (501) for which level C shall apply.
Bend test specimens shall not reveal any one single discontinuity $\geq 3$ mm in any direction. Discontinuities appearing at the edges of a test specimen during testing shall be ignored in the evaluation unless there is evidence that cracking is due to incomplete penetration, slag or other discontinuity. The sum of the greatest discontinuities exceeding 1 mm but less than 3 mm in any one bend specimen shall not exceed 10 mm.

If the imperfections in the welder’s test piece exceed the permitted maximum specified, then the welder fails the test.

Reference should also be made to the corresponding acceptance criteria for non-destructive testing. Specified procedures shall be used for all destructive and non-destructive testing.

8 Re-tests

If any test fails to comply with the requirements of this standard, the welder may be given the opportunity to repeat the qualification test once without further training.

9 Period of validity

9.1 Initial qualification

The welder’s qualification begins from the date of evaluation of the test piece(s), this is providing that the required testing has been carried out and the test results obtained were acceptable. The certificate needs to be confirmed every six months otherwise the certificate(s) become(s) invalid.

The validity of the certificate may be extended as specified by clause 9.3. The chosen method of the extension of qualification in accordance with 9.3, a) or b) or c) shall be stated on the certificate at time of issue.

9.2 Confirmation of the validity

The qualifications of a welder for a process shall be confirmed every six months by the person responsible for welding activities or examiner/examining body. This is confirming that the welder has worked within the range of qualification and extends the validity of the qualification for a further six month period.

This clause is applicable to all options of revalidation in clause 9.3.

9.3 Revalidation of welder qualification

Revalidation shall be carried out by an examiner/examining body.

The skill of the welder shall be periodically verified by one of the following methods:

a) The welder shall be retested every three years.

b) Every two years, two welds made during the last six months of the validity period shall be tested by radiographic or ultrasonic testing or destructive testing and shall be recorded. The acceptance levels for imperfections shall be as specified in clause 7 or in application standards. The weld tested shall reproduce the original test conditions except for thickness and outside diameter. These tests revalidate the welder's qualifications for an additional two years.

c) A welder’s qualifications for any certificate shall be valid as long as it is confirmed according to clause 9.2 and provided all the following conditions are fulfilled.

- the welder is working for the same manufacturer for whom he qualified that is responsible for the manufacture of the product
that manufacturer’s ISO 3834-2 or -3 quality program will need to have been proven by verification

that manufacturer has documented that the welder has produced welds of acceptable quality based on application standards. The welds examined shall confirm the following conditions: welding position(s), weld type (FW, BW), material backing or no material backing.

9.4 Revocation of qualification

When there is a specific reason to question a welder’s ability to make welds that meet the product standard quality requirements, the qualifications that support the welding he is doing shall be revoked. All other qualifications not questioned remain valid.

10 Certificate

It shall be verified that the welder has successfully passed the qualification test. All essential variables shall be recorded on the certificate. If the test piece(s) fail(s) any of the required tests, no certificate shall be issued.

The certificate shall be issued under the sole responsibility of the examiner or examining body. A recommended format is detailed in Annex A. If any other form of welder’s qualification test certificate is used, it shall contain the information required in Annex A. The examiner or examining body is responsible for verifying that all essential variables are addressed in this certificate.

The following non-essential variables shall be recorded on the certificate.

— type of current and polarity,
— parent material group/subgroup,
— shielding gas.

In general for each test piece a separate welder’s qualification test certificate shall be issued.

If more than one test piece is welded a single welder’s qualification test certificate can be issued that combines the ranges of qualification of the individual test pieces. All essential variables for all tests shall be recorded on the combined certificate. In this case, only one of the following essential variables is permitted to differ, except those given in 5.7.

— type of weld,
— welding position,
— deposited thickness.

Other essential variables are not allowed to be changed.

It is recommended that the welder’s qualification test certificates be issued in the local language plus at least one of the following languages: English, French or German.

The examination of job knowledge (see Annex B) shall be designated by “Accepted” or “Not tested”.

In accordance with clause 5.4e) the supplementary fillet weld test shall be recorded on the certificate for associated butt weld qualification.
11 Designation

The designation of a welder qualification shall comprise the following items in the order given (the system is arranged so that it can be used for computerization):

a) the number of this standard;

b) the essential variables:

1) welding processes: refer to 4.2, 5.2 and ISO 4063;

2) product type: plate (P), pipe (T), refer to 4.3.1 and 5.3;

3) type of weld: butt weld (BW), fillet weld (FW), refer to 5.4;

4) filler material group: refer to 5.5;

5) welding consumables: refer to 5.6;

6) dimensions of test piece: deposited thickness s or material thickness t and outside pipe diameter D, refer to 5.7;

7) welding positions: refer to 5.8 and ISO 6947;

8) weld details: refer to 5.9.

The type of shielding and backing gas shall not be incorporated in the designation but shall be included in the welder’s qualification test certificate (see Annex A).
# Annex A

## (informative)

### Welder's qualification test certificate

**Designation(s):**

- ...................................................................................................................
- ...................................................................................................................

**WPS – Reference:**

**Examiner or examining body – Reference No.:**

**Welder’s Name:**

**Identification:**

**Method of identification:**

**Date and place of birth:**

**Employer:**

**Code / testing standard:**

**Job knowledge:** Acceptable/Not tested (Delete as necessary)

### Test piece

<table>
<thead>
<tr>
<th>Welding process(es);</th>
<th>Range of qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transfer mode</td>
<td></td>
</tr>
<tr>
<td>Product type (plate or pipe)</td>
<td></td>
</tr>
<tr>
<td>Type of weld</td>
<td></td>
</tr>
<tr>
<td>Parent material group(s)/subgroups</td>
<td></td>
</tr>
<tr>
<td>Filler material group(s)</td>
<td></td>
</tr>
<tr>
<td>Filler material (Designation)</td>
<td></td>
</tr>
<tr>
<td>Shielding gas</td>
<td></td>
</tr>
<tr>
<td>Auxiliaries (e.g. backing gas)</td>
<td></td>
</tr>
<tr>
<td>Type of current and polarity</td>
<td></td>
</tr>
<tr>
<td>Material thickness (mm)</td>
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<tr>
<td>Deposited thickness (mm)</td>
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<tr>
<td>Outside pipe diameter (mm)</td>
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<tr>
<td>Welding position</td>
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<tr>
<td>Weld details</td>
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<tr>
<td>Multi/single layer</td>
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### Supplementary fillet weld test (completed in conjunction with a butt weld qualification: acceptable/ not acceptable)

<table>
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<th>Type of tests</th>
<th>Performed and accepted</th>
<th>Not tested</th>
<th>Name of examiner or examining body:</th>
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<td>Visual testing</td>
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<td>Place, date and signature of examiner or examining body:</td>
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<tr>
<td>Radiographic testing</td>
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<td></td>
<td>Date of issue : 20/01/07</td>
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<tr>
<td>Fracture test</td>
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<tr>
<td>Bend test</td>
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<tr>
<td>Notch tensile test</td>
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<td>Macroscopic examination</td>
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**Revalidation 9.3a)**

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**Revalidation for qualification by examiner or examining body for the following 2 years (refer to 9.3 b)**

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**Confirmation of the validity by employer/welding coordinator/examiner or examining body for the following 6 month (refer to 9.3 a,b,c)**

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<th>Position or title</th>
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Annex B
(informative)

Job knowledge

B.1 General

The test of job knowledge is recommended, but it is not mandatory.

However, some countries may require that the welder undergoes a test of job knowledge. If the job knowledge test is carried out, it should be recorded on the welder’s qualification test certificate.

This annex outlines the job knowledge that a welder should have to ensure that procedures are followed and common practices are complied with. The job knowledge indicated in this annex is only pitched at the most basic level.

Owing to different training programmes in various countries, it is only proposed to standardize general objectives or categories of job knowledge. The actual question used should be drawn up by the individual country, but should include questions on areas covered in B.2, relevant to the qualification test of welders.

The actual tests of a welder’s job knowledge may be given by any of the following methods or combinations of these methods:

a) written objective tests (multiple choice);

b) oral questioning following a set of written questions;

c) computer testing;

d) demonstration/observation testing following a written set of criteria.

The test of job knowledge is limited to the matters related to the welding process used in the test.

B.2 Requirements

B.2.1 Welding equipment

B.2.1.1 Oxy-acetylene welding

a) Identification of gas cylinders;

b) Identification and assembly of essential components;

c) Selection of correct nozzles and welding blowpipes.

B.2.1.2 Arc welding

a) Construction and maintenance of welding equipment and typical parameters;

b) Type of welding current;

c) Correct connection of the welding return cable.
B.2.2 Welding process 2)

B.2.2.1 Oxy-acetylene welding (311)
   a) Gas pressure;
   b) Selection of nozzle type;
   c) Type of gas flame
   d) Effect of overheating.

B.2.2.2 Manual metal-arc welding with covered electrode (111)
   a) Classification of electrodes

B.2.2.3 Gas and self shielded metal-arc welding (114, 13, 14, 15)
   a) Types and size of electrodes;
   b) Identification of shielding gas and flow rate (without 114);
   c) Type, size and maintenance of nozzles/contact tip;
   d) Selection and limitations of transfer mode;
   e) Protection of the welding arc from draughts.

B.2.2.4 Submerged arc welding (121, 125)
   a) Drying, feeding and correct recovery of flux;
   b) Correct alignment and travel of welding head.

B.2.3 Parent metals
   a) Identification of material;
   b) Methods and control of pre-heating;
   c) Control of interpass temperature.

B.2.4 Welding consumables
   a) Identification of welding consumables;
   b) Storage, handling and conditions of welding consumables;
   c) Selection of correct size;
   d) Cleanliness of electrodes and filler wires;

2) The numbers refer to ISO 4063.
e) Control of wire spooling;
f) Control and monitoring of gas flow rates.

B.2.5 Safety precautions

B.2.5.1 General

a) Safe assembly, setting up and turn off procedures;
b) Safe control of welding fumes and gases;
c) Personal protection;
d) Fire hazards;
e) Welding in confined spaces;
f) Awareness of welding environment

B.2.5.2 Oxy-acetylene welding

a) Safe storage, handling and use of compressed gases;
b) Leak detection on gas hoses and fittings;
c) Procedure to be taken in the event of a flashback.

B.2.5.3 All arc welding processes

a) Environment of increase hazard electric shock;
b) Radiation from the arc;
c) Effects of stray arcing.

B.2.5.4 Gas-shielded metal arc welding

a) Safe storage, handling and use of compressed gases;
b) Leak detection on gas hoses and fittings.

B.2.6 Welding sequences/procedures

Appreciation of welding procedure requirements and the influence of welding parameters.

B.2.7 Joint preparation and weld representation

a) Conformance of joint preparation to the welding procedure specification (WPS);
b) Cleanliness of fusion faces.

B.2.8 Weld imperfections

a) Identification of imperfections;
b) Causes;
c) Prevention and remedial action.

B.2.9 Welder qualification

The welder shall be aware of the range of the qualification.
Annex C
(informative)

FW/BW test assembly option

FW Test Piece

BW Test Piece

Combined FW/BW Test Piece
Annex ZA
(informative)

Relationship between this International Standard and the Essential Requirements of EU Directives 97/23

By agreement between ISO and CEN, this CEN annex is included in the DIS and FDIS but will not appear in the published ISO standard.

This International Standard has been prepared under a mandate given to CEN by European Commission and the European Free Trade Association to vide one means of conforming to Essential requirements of the New Approach Directive 97/23, Pressure equipment directive.

Once this standard is cited in the Official journal of the European Communities under that Directive and has been implemented as a national standard in at least one Member State, compliance with the normative clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential requirements of that Directives and associated EFTA regulations.

WARNINGS: Other requirements and other EU Directives may be applicable to the products falling within the scope of this standard.